

**Systems Startup and Commissioning (Cx)
Guidelines
For
Guaranteed Energy Savings Program
In
State of Minnesota Facilities**

January 2012

1. Overview of System Startup and Commissioning for State ESPCs

It is the intention of the State of Minnesota Guaranteed Energy Savings Program (GESp) to incorporate industry standard commissioning (Cx) procedures into all energy saving performance contracts (ESPCs) implemented at State owned facilities in Minnesota. Benefits of commissioning include increased building comfort, reduced operational problems, lower installation costs, fewer contractor call-backs, and improved energy performance. The commissioning requirements outlined herein have been adapted from industry standard procedures detailed in ASHRAE's commissioning guidelines^a.

Commissioning ensures that systems are designed, installed, functionally tested in all modes of operation, and are capable of being operated and maintained in conformity with the design intent. Commissioning is a process that begins at project conception and typically ends after project acceptance. Key activities in the commissioning process include documentation of design intent, design reviews, execution of construction checklists, systematic functional testing of equipment and systems, oversight of training for operations and maintenance staff, and follow-up on any warranty issues.

The requirements and expectations of the commissioning process during the phases of an ESPC are outlined herein.

2. Commissioning Process for ESPCs

Because of the design-build nature of ESPCs, the details of the commissioning activities are developed along with the project scope, rather than being explicitly defined at the beginning of the project. In an ESPC, commissioning requirements must be: 1) specified in the contract, 2) defined explicitly after design, 3) implemented during construction, 4) completed prior to final project acceptance, and 5) followed-up on after acceptance. The specifics involved in each of these five phases of an ESPC are discussed below.

PHASE 1 - CONTRACT DEVELOPMENT

The scope of work for an ESPC project usually evolves from an Investment Grade Audit (IGA), which includes descriptions of Energy Conservation Measures (ECMs), analyses of energy and cost impacts, and the basis for a savings or performance guarantee. The contract negotiations and scope are completed based on the conceptual design presented in the energy audit. For complex projects, the design is typically about 30% complete at the time of contract award. Since the detailed design of the project often occurs after the contract is in place, it is impractical to define all details of the project's commissioning in the contract. It is critical, however, to include sufficient details on the commissioning process that will be followed for the duration of the project to ensure the benefits of commissioning are realized.

The ESCO shall outline the project's specific commissioning requirements. The key items that should be specified include:

- Qualifications and affiliation of the Commissioning Agent (CxA);
- Roles and responsibilities of CxA, ESCO and State Institution, including witnessing of Cx activities;
- Process that will be followed to document the design intent or State Institution's project requirements for each energy conservation measure (ECM) or system;
- Requirements for State Institution or 3rd party design reviews or submittal approvals;
- Schedule for developing and approving a Cx plan, including expected content such as:
 - Pre-functional inspections,
 - Functional testing procedures,
 - Required use of manufactures' start-up procedures,
 - Plan for seasonal testing and conditional acceptance, if needed;
- Contents and timing of periodic project reports, Final Cx Report, and Systems Manual;
- Requirements for CxA oversight of O&M training; and
- Plan for warranty walk-through or other follow-up procedures.

^a ASHRAE Guideline 1-1996 The HVAC Commissioning Process and ASHRAE Guideline 0-2005 The Commissioning Process

The ESCO shall designate both the affiliation and qualifications of the Commissioning Agent (CxA) that will lead the commissioning process for the project. The key responsibilities of the CxA are: 1) Directing the commissioning team in the completion of the commissioning requirements; 2) Overseeing or performing the commissioning tests; and 3) Verifying the adequacy of the commissioning results.

It is common practice that the CxA will be a qualified member of the ESCOs staff that is doing the commissioning, making sure that sufficient time and resources are allocated for fulfillment of this role. In some cases it may be beneficial for the CxA to be from an independent third party reporting directly to the State Institution.

In ESPCs, when the CxA is from the ESCO, the CxA should NOT be part of the design or construction management team, but another individual that meets the prescribed qualifications. In some cases, however, utilizing project funds to engage a 3rd party commissioning agent, rather than have the ESCO utilize internal resources, is advisable. While it is essential that contractors verify and test the installed systems, formal commissioning requires independent oversight that ensures the State Institution's best interests are maintained.

Key qualifications for the individual acting as CxA include: on-site availability, experience executing the Cx process, hands-on experience testing and troubleshooting applicable systems, familiarity with a variety of testing equipment, and detailed understanding of the systems and equipment affected by the project.

In addition to identifying the affiliation and qualifications for the CxA, the State Institution should specify a representative to witness the Cx activities and to resolve any disputes that might arise. The State Institution's Cx representative will also be expected to provide some oversight and approval of the commissioning activities.

The ESCO shall develop a written design intent for each system or ECM installed documenting the State Institution's project requirements. Specific operational parameters, design details, performance requirements (conditions in addition to energy savings), or other provisions that are established by design intent are:

- Operational parameters, such as temperature setback capabilities or operator interface features;
- Requirements for design details or ancillary items, such as sensors, valves, access, electrical, existing equipment demolition, etc.;
- Performance requirements, such as equipment efficiencies, or ton-hours of chilled water to be delivered.

PHASE 2 - PROJECT DESIGN

Once the ESPC contract has been awarded, any remaining design and engineering of the project scope will be completed. Commissioning related activities performed by the Cx team in the design phase include:

- ESCO completes project design;
- State Institution and CxA review design and approve equipment submittals;
- ESCO and State Institution document the design intent for each ECM or system;
- CxA develops a draft Cx Plan, including the specifics of all pre-functional inspections and functional performance tests;
- CxA develops Cx specifications for project (if needed);
- State Institution and ESCO review and accept Cx documents;
- CxA issues Final Commissioning Plan and specifications.

PHASE 3 - CONSTRUCTION

After the design and commissioning plan have been finalized, construction will begin. Cx related activities that occur during the construction phase include:

- Construction observation by State Institution's Cx representative and Commissioning Agent;
- Periodic Cx meetings are held with the project team;
- Cx progress reports are submitted by the CxA;
- Pre-functional inspections are completed and certified by the ESCO prior to equipment start-up and functional testing;
- Manufactures' start-up procedures are completed by the ESCO or manufacturer's representative.

PHASE 4 - PROJECT ACCEPTANCE

Once construction is complete and ready for acceptance by the State Institution, the functional performance tests are executed and the procedures are documented by the CxA. The CxA documents the test results, explicitly including how the State Institution's project requirements or design intent prescribed for each system were met. Any items that did not pass shall be tracked and presented to the project team in a deficiency log. The ESCO will rectify the items and then perform a retest in the presence of the CxA to confirm that the items have been fixed. The deficiency log is then updated by the CxA, noting the date and corrective action taken. The State Institution may choose to specify consequences for multiple failed re-tests to limit the possibility of excessive use of the CxA's time.

The ESCO then assembles the Final Commissioning Report or a Systems Manual, at a minimum, a Final Cx Report should be provide the following:

- Commissioning summary report;
- ESCO certified pre-functional checklists;
- Completed manufacturers start-up sheets;
- Results of functional testing and verification of system performance;
- Detailed operating procedures / sequences of operations;
- Closed out deficiency log;
- Overview of training provided to O&M staff.

Some State Institutions may prefer to receive a more comprehensive Systems Manual, which is required for LEED certification. A systems manual typically brings together comprehensive project documentation including:

- State Institution's project requirements or design intent;
- Schematic system drawings;
- Approved submittals;
- Recommended record keeping procedures;
- Maintenance procedures & schedules;
- Test requirements for ongoing commissioning.

PHASE 5 - POST-ACCEPTANCE PHASE

Commissioning activities that typically extend beyond Project Acceptance include deferred functional testing and warranty verification.

Often times, some functional testing may be postponed until seasonal conditions are appropriate to evaluate the system. When some functional testing has been deferred, acceptance of the project is conditional upon the success of the scheduled tests.

Most equipment installed will have a one-year warranty provided by the manufacturer. A warranty check-out with the ESCO after 8 to 10 months of operation is a recommended commissioning activity. Reviewing the equipment warranties and performing a site walk-through at this time can identify any problems that may still be covered by a manufacturer's or contractor's warranty.